

**WHAT IS CLAIMED IS:**

- 1    1.    An apparatus for an internal combustion engine,  
2    comprising:  
3        a variation calculating section to calculate a variation  
4    of an engine oil-diluting fuel which is fuel leaking out  
5    through a clearance between a piston and a cylinder of the  
6    engine and diluting an engine oil; and  
7        an oil-diluting fuel quantity calculating section to  
8    determine an oil-diluting fuel quantity in accordance with  
9    the variation.
- 1    2.    The apparatus as claimed in Claim 1, wherein the  
2    variation calculating section calculates the variation in  
3    accordance with an engine temperature.
- 1    3.    The apparatus as claimed in Claim 1, wherein the  
2    variation calculating section comprises an increase  
3    calculating section to calculate an increase quantity of the  
4    engine oil-diluting fuel quantity, and a decrease calculating  
5    section to calculate a decrease quantity of the engine oil-  
6    diluting fuel quantity; and the oil-diluting fuel quantity  
7    calculating section calculates the oil-diluting fuel quantity  
8    in accordance with the increase quantity and the decrease  
9    quantity.
- 1    4.    The apparatus as claimed in Claim 3, wherein the  
2    increase calculating section calculates the increase quantity  
3    of the engine oil-diluting fuel quantity in accordance with  
4    an engine temperature, an engine speed and an engine  
5    load.

1 5. The apparatus as claimed in Claim 4, wherein the  
2 engine temperature is an engine cylinder wall temperature.

1 6. The apparatus as claimed in Claim 3, wherein the  
2 decrease calculating section calculates the decrease  
3 quantity of the engine oil-diluting fuel quantity in  
4 accordance with an engine temperature, and an engine  
5 speed.

1 7. The apparatus as claimed in Claim 6, wherein the  
2 engine temperature is an engine oil temperature.

1 8. The apparatus as claimed in Claim 3, wherein the  
2 decrease calculating section calculates a decrease rate  
3 which is a rate of decrease of the oil-diluting fuel quantity,  
4 and which represents a rate of evaporation of the oil-  
5 diluting fuel, to determine the decrease quantity in  
6 accordance with the decrease rate.

1 9. The apparatus as claimed in Claim 1, wherein the oil-  
2 diluting fuel quantity calculating section calculates the oil-  
3 diluting fuel quantity by integrating the variation.

1 10. The apparatus as claimed in Claim 9, wherein the  
2 variation calculating section determines a value of the  
3 variation periodically, and the oil-diluting fuel quantity  
4 calculating section calculates the oil-diluting fuel quantity  
5 by adding a current value of the variation to a previous  
6 value of the oil-diluting fuel quantity.

1 11. The apparatus as claimed in Claim 9, wherein the  
2 variation calculating section comprises an increase  
3 calculating section to calculate an increase quantity of the  
4 engine oil-diluting fuel quantity, and a decrease calculating  
5 section to calculate a decrease quantity of the engine oil-  
6 diluting fuel quantity; and the oil-diluting fuel quantity  
7 calculating section calculates the oil-diluting fuel quantity  
8 by integrating the increase quantity and the decrease  
9 quantity.

1 12. The apparatus as claimed in Claim 11, wherein the  
2 increase calculating section calculates the increase quantity  
3 of the engine oil-diluting fuel quantity in accordance with  
4 an engine cylinder wall temperature, an engine speed and  
5 an engine load, and wherein the decrease calculating  
6 section calculates the decrease quantity of the engine oil-  
7 diluting fuel quantity in accordance an engine oil  
8 temperature and the engine speed.

1 13. The apparatus as claimed in Claim 1, wherein the  
2 variation calculating section determines an oil-diluting  
3 temperature component quantity for each of engine  
4 temperature regions, and the oil-diluting fuel quantity  
5 calculating section calculates the oil-diluting fuel quantity  
6 from the oil-diluting temperature component quantities.

1 14. The apparatus as claimed in Claim 13, wherein the  
2 variation calculating section varies the oil-diluting

3 temperature component quantity of each temperature  
4 region in accordance with an engine temperature.

1 15. The apparatus as claimed in Claim 14, wherein the  
2 variation calculating section comprises an increase  
3 calculating section to calculate an increase quantity of the  
4 engine oil-diluting fuel quantity, and a decrease calculating  
5 section to calculate a decrease quantity of the engine oil-  
6 diluting fuel quantity; and the oil-diluting fuel quantity  
7 calculating section updates a collection of the oil-diluting  
8 temperature component quantities in accordance with the  
9 increase quantity and the decrease quantity, and calculates  
10 the oil-diluting fuel quantity by using the collection updated.

1 16. The apparatus as claimed in Claim 15, wherein the  
2 increase calculating section calculates the increase quantity  
3 of the engine oil-diluting fuel quantity in accordance with  
4 an engine cylinder wall temperature, an engine speed and  
5 an engine load, and wherein the decrease calculating  
6 section calculates the decrease quantity of the engine oil-  
7 diluting fuel quantity in accordance an engine oil  
8 temperature and the engine speed.

1 17. The apparatus as claimed in Claim 15, wherein the oil-  
2 diluting fuel quantity calculating section adds the increase  
3 quantity to each of the oil-diluting temperature component  
4 quantities in the collection.

1 18. The apparatus as claimed in Claim 15, wherein the oil-  
2 diluting fuel quantity calculating section decreases the oil-

3 diluting temperature component quantity of each  
4 temperature region if the temperature region is a region  
5 lower than or equal to a current engine temperature.

1 19. The apparatus as claimed in Claim 1, wherein the  
2 apparatus further comprises a condition discriminating  
3 section to check the oil-diluting fuel quantity to determine  
4 whether a predetermined permitting condition is satisfied,  
5 and an alcohol concentration calculating section to  
6 calculate an alcohol concentration of a fuel when the  
7 permitting condition is satisfied.

1 20. The apparatus as claimed in Claim 19, wherein the  
2 permitting condition is satisfied when the oil-diluting fuel  
3 quantity is smaller than or equal to a predetermined value.

1 21. The apparatus as claimed in Claim 19, wherein the  
2 permitting condition is satisfied when at least one of first  
3 and second conditions is satisfied, the first condition being  
4 a condition which is satisfied when the oil-diluting fuel  
5 quantity is smaller than or equal to a predetermined value,  
6 the second condition is a condition which is satisfied when  
7 the variation of the oil-diluting fuel quantity is smaller than  
8 or equal to a predetermined variation value.

1 22. The apparatus as claimed in Claim 1, wherein the oil-  
2 diluting fuel quantity calculating section modifies the oil-  
3 diluting fuel quantity in accordance with a fuel injection  
4 quantity of fuel injected into the engine.

1 23. The apparatus as claimed in Claim 1, wherein the  
2 apparatus comprises an engine control section to control  
3 the engine in accordance with the oil-diluting fuel quantity.

1 24. The apparatus as claimed in Claim 23, wherein the  
2 engine control section adjusts a fuel injection quantity in  
3 accordance with the oil-diluting fuel quantity.

1 25. A process for an internal combustion engine, the  
2 process comprising:  
3 calculating a variation of an engine oil-diluting fuel  
4 which is fuel leaking out through a clearance between a  
5 piston and a cylinder of the engine and diluting an engine  
6 oil; and  
7 determining an oil-diluting fuel quantity in accordance  
8 with the variation.

1 26. An engine control system of an internal combustion  
2 engine, the system comprising:  
3 an input section to sense an engine operating  
4 condition;  
5 a control unit to calculate a variation of an engine oil-  
6 diluting fuel which is fuel leaking out through a clearance  
7 between a piston and a cylinder of the engine and diluting  
8 an engine oil, to determine an oil-diluting fuel quantity in  
9 accordance with the variation, and to produce a control  
10 signal by using the oil diluting fuel quantity; and  
11 an output section to control the engine in response to  
12 the control signal.

1 27. An apparatus for an internal combustion engine, the  
2 apparatus comprising:  
3 means for calculating a variation of an engine oil-  
4 diluting fuel quantity successively in accordance with an  
5 engine temperature; and  
6 means for determining the oil-diluting fuel quantity in  
7 accordance with successively calculated values of the  
8 variation.